J. Dairy Sci. 101:1–12
https://doi.org/10.3168/jds.2017-13851

Effects of feeding milk replacer at 2 rates with pelleted, low-starch or texturized, high-starch starters on calf performance and digestion

J. D. Quigley,[1] T. M. Hill, T. S. Dennis, F. X. Suarez-Mena, and R. L. Schlotterbeck
Nurture Research Center, Provimi, Brookville, OH 45309

ABSTRACT

Milk replacer (MR) feeding programs have traditionally fed at less than ad libitum amounts to promote calf starter (CS) intake and allow early weaning. More recently, increased amounts of MR preweaning have been shown to increase preweaning ADG, although postweaning growth may be reduced. Several studies suggest that limited postweaning digestion of nutrients in CS may contribute to postweaning growth impairment. It is not clear whether CS formulation might also contribute to differences in postweaning nutrient digestion when calves are fed different MR programs. A 56-d feeding and digestion trial was conducted to compare growth and digestion in 2- to 3-d-old male Holstein calves (n = 48; initially 41.9 kg of body weight) fed a moderate (MRM) or high (MRH) MR program and either a pelleted CS containing 9.9% starch or a texturized CS containing 41.3% starch. Programs were 0.66 kg of dry matter (DM)/d of MR to d 46, then 0.33 kg/d to d 49 (MRM) and 0.85 kg of DM/d to d 5, then 1.07 kg/d to d 42, then 0.53 kg/d to d 49 (MRH). The MR contained 25% crude protein and 18.6% fat and was reconstituted to 13 (MRM) or 15% (MRH) solids. Calves were also assigned randomly to receive a pelleted CS (9.9% starch, 36.9% NDF) or a textured CS (41.3% starch, 13.3% NDF) and water for ad libitum intake for 56 d. During d 31 to 35 and 52 to 56, fecal samples were collected from 5 calves per treatment for estimates of digestibility. Selected nutrients and chromic oxide (d 31–35) or acid-insoluble ash (d 52–56) were analyzed in feed and feces to estimate digestibility. Data were analyzed as a completely randomized design. Repeated measures analysis was performed when data were measured by week. Calves fed MRH gained more body weight (but not hip width) and were more efficient to weaning compared with calves fed MRM, although fecal scores and days treated with medications were greater. We found no effect of CS on animal performance, although calves fed textured CS had higher fecal scores. Digestibilities of nutrients were affected by treatment and time of sampling (5 or 8 wk). At 5 wk, digestion of DM, organic matter, crude protein, and fat were lower and digestion of acid detergent fiber, neutral detergent fiber, and starch were higher in calves fed MRM and reflected greater CS intake. Also, digestion of DM, organic matter, acid detergent fiber, starch, crude protein, and fat were greater in calves fed textured CS at 5 wk. By 8 wk, when CS was the only source of nutrients, digestion of DM, organic matter, acid detergent fiber, and neutral detergent fiber were greater in calves fed MRM and digestion of DM and organic matter were greater, and acid detergent fiber and neutral detergent fiber digestion were lower in calves fed textured CS. Formulation of CS as well as amount of MR offered to young calves influenced animal performance and digestion in this study.

Key words: calves, intake, digestion, growth

INTRODUCTION

Calves are commonly weaned between 1 and 3 mo of age in many dairy systems, with the most common age being approximately 9 wk in the United States (USDA, 2016). Weaning to dry feed requires that the calf has sufficiently developed gastrointestinal, hepatic, and peripheral enzyme systems to utilize changing sources of nutrients. If a calf is inadequately prepared for weaning, performance may suffer and predispose calves to reduced growth, poor efficiency, and increased susceptibility to disease (Roth et al., 2008, 2009).

The most important factor in promoting rumen development and preparation for weaning is consumption of dry feed containing fermentable carbohydrates that are fermented to propionate and butyrate in the rumen by resident rumen bacteria (Flatt et al., 1958; Sander et al., 1959). Production of VFA and microbial protein stimulate a series of adaptations in the rumen, gastrointestinal tract, hepatic tissues, and systemically that promote gluconeogenesis, production and release of BHB by rumen epithelium, and utilization of acetate by peripheral tissues (Howarth et al., 1968; Huber et al., 1961; Huber, 1969; Baldwin et al., 2004).

Received September 18, 2017.
Accepted March 3, 2018.
[1]Corresponding author: jquigley@provimi-na.com

Feeding milk or MR in excess of the traditional recommendations (approximately 10% of BW as milk or reconstituted MR) has been shown to increase rate of gain and take advantage of improved feed efficiency (Diaz et al., 2001; Moallem et al., 2010; Davis-Rincker et al., 2011). High digestibility and metabolizability of liquid feeds compared with higher-fiber ingredients in calf starter (CS) may contribute to greater efficiency of BW gain.

Calves fed milk for ad libitum consumption or MR in amounts >1 kg of powder per day gain more BW than calves fed conventional amounts (Jasper and Weary, 2002; Moallem et al., 2010). However, BW gain after weaning may be reduced due to inadequate preweaning starter intake and lack of rumen development. Weaning program also influences CS intake (Sweeney et al., 2010; de Passillé et al., 2011; Meale et al., 2015) and may contribute to lower digestion of nutrients postweaning. Some researchers suggest delayed weaning (>8 wk of age) may reduce the reduction in BW gain due to weaning (de Passillé et al., 2011; Eckert et al., 2015; Meale et al., 2015).

Terré et al. (2007) fed Holstein bull calves (19 d of age at start of the trial) milk replacer (**MR**) at 4 L/d with weaning at 35 d of the study, or an MR program that increased to 7 L/d and then was reduced to weaning at 35 d. Those authors reported that digestion of NDF was lower in calves fed 7 L/d compared with 4 L/d (20.3 vs. 34.7%). Since disappearance of NDF is due primarily to ruminal fermentation, it is likely that reduced NDF digestion was due to inadequate or incomplete rumen fermentation in calves fed 7 L/d. Reduced NDF digestibility occurred despite a higher rumen pH (5.73 vs. 5.99). Others (Hill et al., 2010; Chapman et al., 2016) also reported lower postweaning nutrient digestion when calves were fed high amounts of MR preweaning.

Chapman et al. (2016) reported that digestion of nutrients, but particularly digestion of NDF and ADF, was reduced during the digestion period of d 52 to 58 of age when calves were fed MR up to 0.87 kg/d. Although digestion of all nutrients except starch was reduced significantly when calves were fed greater amounts of MR, digestion of NDF and ADF were reduced nearly 50% in calves fed large amounts of milk preweaning.

It is unclear whether amount of MR fed or the type of CS used might influence digestion of nutrients and subsequent growth. Therefore, the objective of our study was to evaluate digestion and performance of calves when fed 2 levels of MR and CS containing different levels of starch and fiber. Commercial high-starch CS (≥40%) are typically manufactured as texturized feeds containing pellets and whole or processed grains, whereas commercial pelleted CS typically contain lower starch (≤25%) and a greater proportion of higher NDF ingredients, such as soybean hulls and wheat middlings. We used this approach in manufacturing of feeds used in the current study.

MATERIALS AND METHODS

Holstein bull calves (n = 48; 41.9 kg of BW, SE = 0.7; 2 to 3 d of age) were born at a single dairy farm and transported 3.5 h to the experimental site. Calves were weighed on the day after arrival, blood was collected by jugular venipuncture, and serum was separated by centrifugation at 3,000 × *g* at 20°C for 15 min (VWR, Batavia, IL). Total serum protein concentration was estimated using an optical refractometer (ATAGO U.S.A. Inc., Bellevue, WA).

Calves were assigned randomly to receive either (DM basis) 0.66 kg/d of MR powder (25% CP, 18% fat; Provimi, Brookville, OH) to d 46, then 0.33 kg/d to weaning at d 49 (**MRM**), or 0.85 kg/d to 5 d, then 1.07 kg/d to d 42, then 0.53 kg/d to weaning at d 49 (**MRH**). Milk replacers were reconstituted to 13 (MRM) or 15% (MRH) solids with warm water (45°C) and fed at approximately 0600 and 1600 h via buckets with nipples. Milk refusals were collected approximately 60 min after each feeding, weighed, and discarded. Calves were also assigned randomly to receive either a pelleted, low-starch (**LSPEL**) or texturized, high-starch (**HSTEX**) CS (Table 1). Starters LSPEL and HSTEX varied by ingredient (Table 1), contained similar amounts of protein and fat, but differed in amount of starch and fiber (Table 2). Starters and water were offered once daily at approximately 0800 h and were available for ad libitum consumption.

Table 1. Ingredient composition of starter feeds

Ingredient, % as-fed	Low-starch pelleted	High-starch textured
Soybean hulls	41.32	—
Wheat middlings	30.00	5.62
Soybean meal, 48% CP	17.99	23.91
Corn, whole	—	37.00[1]
Oats, whole	—	25.00[1]
Alfalfa meal	—	0.70
Maltodextrin	2.50	0.70
Molasses	2.50	3.00[1]
Fat	2.00	0.26
Calcium carbonate	0.44	1.27
Monocalcium phosphate	0.33	0.78
Magnesium oxide, 54% Mg	—	0.30
Additives[2]	2.92	1.46

[1]Not added to the pellet.

[2]Additives: Clarifly (Central Garden & Pet Co., Schaumburg, IL) 0.67%, salt, vitamin/mineral premix, Bovatec (Zoetis, Parsippany, NJ) premix, binder.